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Rob Kuper

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JOINING THE GREAT PLAINS IN SPACE, PLACE, AND TIME QUESTIONING A TIME ZONE BOUNDARY

ROB KUPER

Standard time zone boundaries are invisible in the landscape, yet they abruptly delineate a temporal difference of one hour between two large areas located relative to one another on Earth. In most cases, standard time zone boundaries follow political ones and define areas within which daylight saving time (DST)—the seasonal advancement of standard time by one hour—is observed. Moving time zone boundaries and the decision to observe daylight saving time occurs throughout

Key Words: climate, commerce, daylight saving time, Nebraska, water

Rob Kuper is assistant professor of landscape architecture at Temple University and a registered landscape architect. He received a Bachelor of Science in Environmental Design and a Master of Landscape Architecture from Auburn University. In 2004, he walked from west to east across Nebraska, his birthplace, to learn more about the landscape. The walk served as a catalyst for research regarding perceptions of space, place, time, and water in landscapes.

the world for various reasons that result in the synchronization of socioeconomic and political activities within and between communities and the simultaneous separation from others.

The zone boundary between mountain standard time (MST) and central standard time (CST) in the Great Plains of the United States now follows the mostly rectilinear political boundaries of counties and states from the Canadian border in the north to the Mexican border in the south. North and South Dakota, Nebraska, Kansas, and Texas are bisected by the standard time zone boundary. All Plains states observe DST. Two consequences result from this current configuration: first, communities on either side of the MST-CST zone boundary are united by time but may not be related by environmental characteristics; and second, that observing or eliminating DST in one state depends upon observance or elimination in neighboring states.

Sutherland and Paxton, Nebraska, illustrate the first consequence. These towns are approximately twelve miles apart but lie in different counties and standard time zones, and are accordingly synchronized with socioeconomic activities in the Midwest or the

Plains and Rocky Mountains. Paxton keeps MST, the same time as Ogallala, Oshkosh, and Scottsbluff in Nebraska, Torrington and Cheyenne in Wyoming, and Fort Collins and Denver in Colorado. Sutherland keeps CST, as do communities farther east—Kearney, Grand Island, North Platte, and Omaha, Nebraska, and Kansas City, St. Louis, and Chicago.

Historically, the twenty-inch isohyet—the line that connects locations of average annual rainfall totaling twenty inches—has been used to distinguish the Great Plains from the Midwest. West of this line, rainfall totals less than twenty inches annually, the climate is arid to some degree, and irrigation is considered necessary for successful agriculture, the dominant land use. East of this line, rainfall exceeds twenty inches annually, the climate is more humid, and irrigation in agriculture is generally considered unnecessary. Lying beneath and straddling the isohyet is the Ogallala aquifer: 3 billion acre-feet of water in gravel beds up to 300 feet thick that have supplied farmers and ranchers since the 1960s.¹

Unfortunately, the MST-CST zone boundary does not synchronize communities that are closely related by climate and land use. To date, no attempt has been made to align the MST-CST zone boundary, isohyet, and to some extent, the use of the aquifer, although they are located close to one another in the landscape (Fig. 1). Aligning them has the potential to define the Great Plains socioeconomically, ecologically, geologically, spatially, and temporally using one line.

A January 2011 proposal to eliminate daylight saving time in Nebraska illustrates the second consequence of how time is currently observed in the Great Plains.² Nebraska state senator Ken Shilz and three residents stated that doing away with daylight saving time would remove the health, social, and business disruption that typically occurs with the seasonal time change.³ The bill went no further than a hearing before the Government, Military, and Veterans Affairs Committee, due in part to the realization that eliminating DST would temporally isolate Nebraska from every

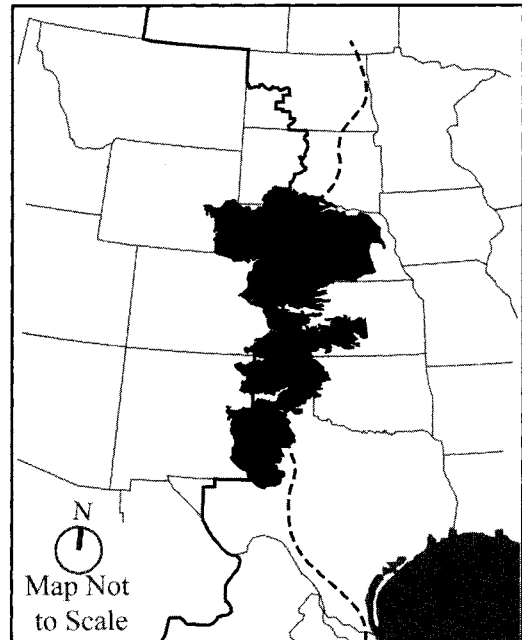


FIG. 1. The current boundary of the mountain standard time and central standard time (MST-CST) zones, the twenty-inch isohyet (dashed), and the approximate area of the Ogallala aquifer. All maps were created by the author.

other state it abuts by one hour during the spring and summer. The elimination of daylight saving time throughout the Great Plains would require the five states currently bisected by the standard time zone boundary to petition to move the MST-CST zone boundary to state boundaries. Thus, the communities within these states could ensure that they would be temporally connected to those to the west or east at one time of the year or another. For example, Arizona, the only state within the contiguous forty-eight United States that does not observe DST, follows MST with states to the north and east during standard time, but follows Pacific Daylight Time with California and Nevada during DST.⁴ Although the boundaries of the states from North Dakota to Texas approximate the climatic boundary of the Great Plains less accurately than the county boundaries may, the state boundaries have been used to distinguish the legal use of surface water in waterways.⁵ Thus, a regional,

spatial, political, hydrological, and temporal alignment is possible with a move of this sort.

This article examines the potential use of the MST-CST zone boundary to define the eastern edge of the Great Plains. The introduction of two problems prefaces the study and provides the reasoning for examining two possible moves: aligning the MST-CST zone boundary with the twenty-inch isohyet, and aligning the MST-CST zone and state boundaries. This study will address both problems through looking at the former using information gathered from county representatives whose constituents would be affected. The latter is examined by reviewing legislation related to standard time changes. Obstacles that prevent either change to the standard time zone boundaries conclude the study.

JUSTIFYING A MOVE

As it is, defining the boundary between the Midwest and Great Plains is difficult. Unlike its sudden and striking mountainous end in the west, the Plains gradually materializes in the east. This in turn creates at least two problems that adversely affect Great Plains land and people. The first has to do with the creation and enforcement of water conservation policies in the present, the second with possible effects on land use in the future caused by global climatic change. Ideally, the differences in average annual rainfall that exist on opposite sides of the isohyet, between the Great Plains and Midwest, should result in differences in water demand and usage. In reality, water demand and usage for agriculture in the Great Plains are high and rely on the finite supply of groundwater in the Ogallala aquifer instead of rainfall.⁶ Over twenty years ago, in southwestern Kansas and the panhandle of Texas, records of groundwater levels showed dramatic drops, in some locations beyond 100 feet.⁷ In 2007 these areas grew in size, and declines exceeded 150 feet.⁸ A sudden disruption in or termination of access to the aquifer in this semiarid to arid climate could make the land, economy, and

culture in the Great Plains susceptible to erosion, recession or depression, and collapse.

Moreover, global climatic change will likely affect demands placed upon the aquifer and other aspects of agriculture in the Plains in some unknown capacity. Climatic change models consistently suggest that increasing concentrations of greenhouse gases could increase the temperature in the Great Plains, but the models vary as to whether precipitation could increase or decrease.⁹ Consequently, crop yields in corn, soybean, winter wheat, alfalfa, and clover hay may decline or increase and become more or less variable depending on the model and the magnitude of temperature and carbon dioxide concentration increases used in the model.¹⁰ Evapotranspiration rates, water yields, and variation in yields may be similarly affected in major watershed resource regions.¹¹ Regardless, irrigation is shown to decline due to either a reduction of water supply following declining precipitation or plentiful increases in precipitation that would render irrigation generally unnecessary.¹² Models have also shown that rising ambient air temperatures and increasing concentrations of carbon dioxide, coupled with other weather-related variables, could decrease the number of days needed to grow confined swine in the west and north, and increase it in the east and south; increase the time needed for beef cattle to mature throughout the Plains; and decrease milk production by dairy cattle throughout the Plains.¹³ The distribution and population of native grasses and birds could also change.¹⁴ The economic implications are equally uncertain given the possibilities outlined in the models. Declines in crop yields may shift land use to pasturage, give an economic advantage to foreign crop producers, and increase the prices consumers may pay for grain products; an increase in yields may result in an increase in land use for crops, a domestic advantage in crop production, and a reduction in costs to consumers.¹⁵ This latter study suggested analyzing economic climatic change models by region to account for geographical variations that exist. However, figures illustrating the possible effects of climatic

change by model in the former studies often show that changes could result in a gradient that approximately follows the twenty-inch isohyet.

Clearly defining the Great Plains along this line is needed to monitor future climatic and economic changes and impose policies for conservation and adaptation. Generally, lines help organize relationships people have with one another and the land.¹⁶ They are easy to comprehend, communicate, mark, and enforce in the landscape. Lines comprising artificial boundaries spatially define the area within which socially derived laws and policies are imposed. In contrast, a line defining a natural variable like the isohyet inherently misrepresents the variable as fixed rather than fluctuating. Nonetheless, correlating lines that denote social or political bodies and the approximate average location of natural variables reflects a relationship that acknowledges both social and natural restrictions.

Using a modified MST-CST zone boundary as a regional boundary appears logical for at least three reasons, each addressing a different scale—regional, individual, and communal—at which Great Plains space, place, and time can be understood. First, and most obvious, is to organize and define climatic, ecological, social, and economic variables on a regional scale within the Great Plains. The amount of annual rainfall received in the region, natural range of Plains flora and fauna, water conservation and use, land use and the businesses supporting and stemming from it, and when and where communities exchange goods, services, and information could all be related.

Second, aligning the MST-CST zone boundary with either the isohyet or state boundaries may make it easier for individuals to distinguish the Great Plains from the Midwest in the landscape. This occurs in two ways. First, isohyets and boundaries between watersheds, states, counties, municipalities, and resource districts can be easily ignored. Time zone boundaries must be acknowledged: to participate in any social or economic activity, persons crossing the timeline are required

to roll their clocks backward or forward one hour to observe standard (or daylight-saving) time. Missed appointments and limited access to businesses, goods, and services are consequences of failing to observe time zones. Secondly, the creation of a “temporal illusion” or mental adjustment of time upon crossing the boundary requires cognizance of one’s time and place.¹⁷ Conceptually, the Great Plains and the Midwest become about fifty-five miles farther apart than they actually are (the distance traveled by car in one hour). One is asked to think that this place and this time are different. Consequently, the change in perspective could encourage perceptions and behavior that are sensitive to the climatic and environmental characteristics of the Plains.

Finally, moving the MST-CST zone boundary may unify the sense of time and place for communities in the Great Plains. According to J. B. Jackson, time creates a “sense of place,” the distinct quality of a place’s environment: “What brings us together with people is not that we live near each other, but that we share the same timetable: the same work hours, the same religious observances, the same habits and customs.”¹⁸ Furthermore, he asserts that a sense of time organized the landscape in the Plains more than a sense of place did, citing the lack of landmarks and the periodicity of the railroad on the towns through which it passed.

EXAMINING THE POSSIBLE ALIGNMENT

Modifying the MST-CST Zone Boundary for Study

Aligning the MST-CST zone boundary with the state boundaries is a rather straightforward modification to articulate and illustrate: the states through which the isohyet currently passes will share the same time year-round. Aligning the MST-CST zone boundary with the twenty-inch isohyet, on the other hand, required investigating how standard time zone boundaries have been drawn and how studies examining the relationship between climate and land-use policy have defined the eastern

boundary of the Great Plains. In each case county boundaries were used.

Shortly after the *Standard Time Act of 1918* was enacted, the Interstate Commerce Commission (ICC) consulted railroad, state, and municipal representatives and defined standard time zone boundaries along county boundaries with "regard for the convenience of commerce and the existing junction points and division points of common carriers."¹⁹ The grid of county boundaries within states gave the ICC and the U.S. Department of Transportation (DOT), which assumed responsibility for altering time zone boundaries in 1970, great flexibility in defining the MST-CST zone boundary. The relatively small size of the counties compared to states allowed for incremental adjustments around counties that preferred to be in one time zone or another and between communities that were socio-economically separated. Following county boundaries also correlated the observance of standard time with the observance of local county laws, thus aligning temporal, spatial, social, economic, and political facets of the landscape. Changes to time zone boundaries since the *Standard Time Act* were made by petition from state governors, legislators, and county commissioners. These moves were made in order to place counties previously separated by the time zone boundary into the same time zone, to have more sunlight in the evening hours when people are most active, or to synchronize areas that are socially and economically connected.²⁰ More recent changes appear to be for the same reasons.²¹

In at least three Plains studies, county boundaries were used to suggest where conservation and land-use policies should be enacted. The Great Plains Committee, created by President Franklin D. Roosevelt following the Dust Bowl in the 1930s, noted the isohyet and other natural boundaries when defining the eastern boundary of the Great Plains, but ultimately it used existing county boundaries to delineate the area within which soil and water conservation policies could be enacted and enforced by existing political bodies.²² Over a half-century later, Frank Popper examined 1980

census records in the central United States by county and highlighted those counties having fewer than two and six people per square mile (two figures used to define the frontier) on a map.²³ After another twenty years, Deborah and Frank Popper showed counties that lost population between 1990 and 2000 in the states of North and South Dakota, Nebraska, Kansas, Oklahoma, Texas, New Mexico, Colorado, Wyoming, and Montana.²⁴ In each case, the counties that could be classified as frontier and that lost population in the last decade of the twentieth century were those that lie along and west of the twenty-inch isohyet. Ultimately, the Poppers proposed a new outlook for these counties, one that includes the government buying land, turning farmland back to grassland, and replacing cattle with bison. The county boundaries define where policies encouraging this outlook in the future may be enacted and enforced.

Given these examples, hypothetically aligning the MST-CST zone boundary and twenty-inch isohyet in the United States requires moving the time zone boundary eastward to existing county boundaries that lay on or close to the isohyet (Figs. 2 and 3). Large municipalities and communities within relatively comfortable driving distances were generally avoided in anticipation of existing socioeconomic connections.

The western boundaries of South and North Dakota, Nebraska, Kansas, Oklahoma, and Texas were selected as an alternative location for the MST-CST zone boundary, because this boundary has been used in the past to distinguish two water rights laws and because the current time zone boundary is very close to the western boundaries of Kansas, Oklahoma, and Texas. It may be also assumed that the less densely populated western portions of North Dakota, South Dakota, and Nebraska will be less susceptible to socioeconomic disruption when compared to the eastern portions. Eliminating daylight saving time would allow these states to share time with states in the arid west during the spring and summer months when land and water use is highest (Figs. 4 and 5).

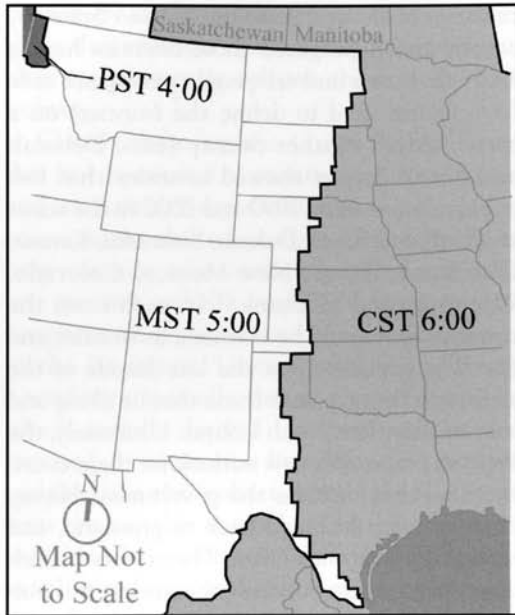


FIG. 2. The MST-CST zone boundary hypothetically aligned with the twenty-inch isohyet.

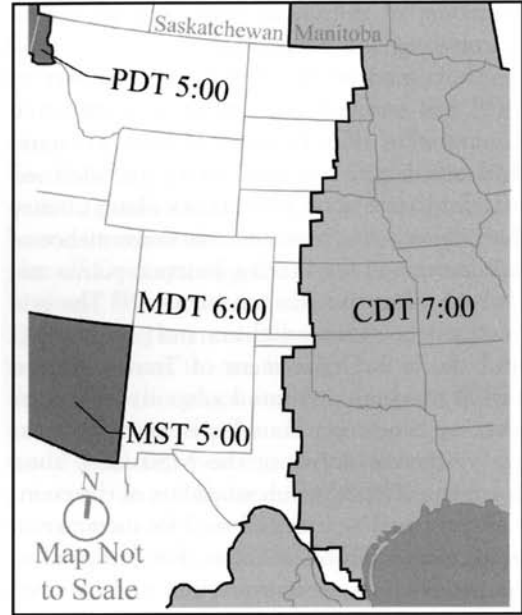


FIG. 3. The MST-CST zone boundary hypothetically aligned with the twenty-inch isohyet during daylight saving time (DST)

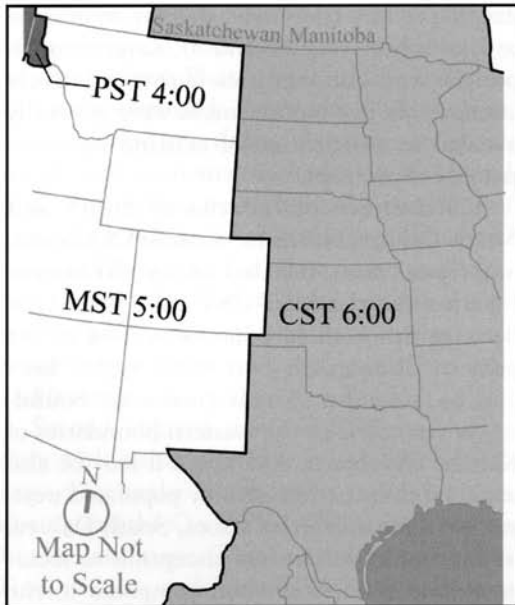


FIG. 4. The MST-CST zone boundary aligned with the western boundaries of North and South Dakota, Nebraska, Kansas, Oklahoma, and Texas. If these states continued to observe DST, this boundary would serve as the mountain daylight time (MDT)-central daylight time (CDT) zone boundary in the United States.

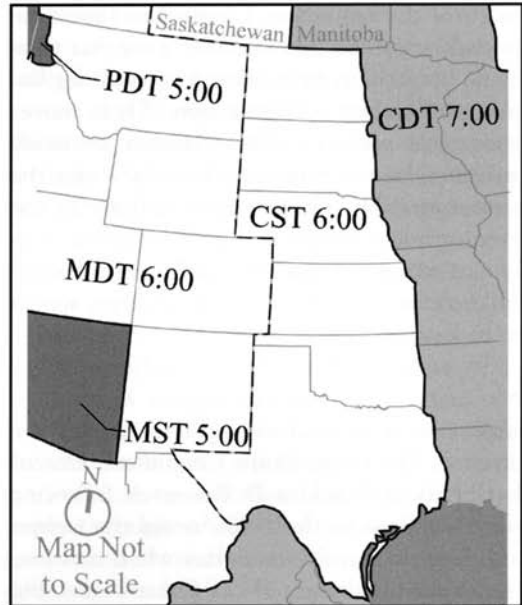


FIG. 5. Time observation during daylight saving time (DST) if North and South Dakota, Nebraska, Kansas, Oklahoma, and Texas eliminated DST. Arizona and Saskatchewan, in Canada, also do not observe DST.

*Potential Impact of the Modified MST-CST
Zone Boundary*

To examine the feasibility of moving the MST-CST zone boundary closer to the twenty-inch isohyet, I contacted representatives of counties and railroads that would be affected. First, a twenty-item questionnaire was sent to county representatives in 121 counties adjacent to the twenty-inch isohyet. Fourteen questions were derived from the U.S. Department of Transportation. It asked for the name of the nearest town where county businesses get supplies and ship to; where residents go for food, clothing, schooling, recreation, healthcare, and religious worship; where local television and radio stations are broadcast from; where local newspapers are published; where bus and rail stations and the local public airport are located; the percentage of residents who commute outside of the county and where they commute to; and the major elements and current state of the community's economy.²⁵ Six additional questions asked representatives to identify the region in which they live, the name of the county they live in, the standard time most residents observe, when they typically wake and retire during the day, and the typical operating hours of businesses in the community.

In order to administer the questionnaire to county representatives, we began by contacting commissioners who are generally knowledgeable about county life and typically involved in requests to change time zone boundaries. Our inability to reach them led to the inclusion of other county representatives in the survey. The contact information for county commissioners was acquired from one of three sources: (1) the National Association of Counties website (www.naco.org); (2) county government websites; or (3) speaking by phone with county auditors, clerks, or assessors. Initially, county commissioners were contacted via e-mail. Those without an e-mail address were contacted by phone. Five weeks after administering the questionnaire via e-mail and phone, thirty-four questionnaires were complete. To

acquire additional completed questionnaires, county auditors and deputy auditors, assessors and deputy assessors, clerks and deputy clerks, or judges who had regular contact with commissioners for monthly or biweekly commission meetings were contacted by phone. An additional thirty-five questionnaires were completed using this method. Overall, sixty-nine of 121 counties were represented in the survey.

A spreadsheet and maps were used to organize and analyze responses. To glean any latitudinal differences that may exist in responses to the six questions that supplemented the DOT-derived questions, the responses were arranged in a spreadsheet by county and state from north to south. Responses to the fourteen questions derived from the DOT were organized into two types of socioeconomic activities—internal and external to the county—and mapped using town or county names provided by respondents. The internal socioeconomic activities were represented by drawing a line that begins and ends on the county seat, thus creating a loop. External socioeconomic activities were represented by connecting the county seat of the county representative responding to the questionnaire and the town, city, or county seat outside the county where goods, services, or information are exchanged. For example, the county representative from Nelson County, North Dakota, stated that most county residents stay within the county to attend religious services but receive radio broadcasts from Devils Lake, to the west in Ramsey County. A loop was drawn on the town of Lakota, the Nelson County seat, to represent the social internal county activity of attendance to religious services. A line representing the social external county activity of listening to radio broadcasts was drawn between the towns of Lakota and Devils Lake. The maps that result using this method indicate basic socioeconomic patterns that exist within and between counties. However, in reality, all other towns, villages, and hamlets lying within county boundaries may have similar or dissimilar connections that may not be reflected in the overall results.

Respondents were contacted again by phone or e-mail after analysis of the maps was completed. Respondents were asked to provide their perspective on how most county residents would feel about (1) eliminating daylight saving time and (2) moving the MST-CST zone boundary to a county boundary relative to the respondents' location. Due to the lapse in time between the first and second contacts, fifty-eight of the original sixty-nine representatives provided responses. The representatives used a Likert-type scale ranging from "strongly favor" to "strongly oppose" and gave short answers to explain their selections.

Representatives from Amtrak and Union Pacific Railroad were also contacted by phone and e-mail to provide perspectives on how modifying the MST-CST boundary would affect railroad operations. Each responded in writing to four questions. They were asked which standard time is used; whether the railroad follows the time zone boundaries that communities use; what operational problems would occur with a MST-CST zone boundary change; and whether the problems are insurmountable.

Questionnaire Results

Current socioeconomic patterns in North Dakota. The city of Fargo, in Cass County, and Grand Forks, in Grand Forks County, appear to have numerous socioeconomic connections to the counties in eastern North Dakota that were queried (Fig. 6). A MST-CST zone boundary aligned with the twenty-inch isohyet may, given the data, cause little disruption to socioeconomic relationships that currently exist in all but four counties in the extreme southeastern portion of the state. Questionnaires from representatives of Dickey, Ransom, Sargent, and Richland Counties were not completed. Given the proximity of these counties to Fargo, and the importance Fargo appears to play in other, more distant counties, it is likely that these four counties are closely linked to Fargo, too. Socioeconomic disruption is likely within these four counties.

The map does not illustrate what, if any, socioeconomic relationships span the North Dakota–Minnesota state boundary, but a follow-up question to representatives did. When asked how most county residents would feel about moving the time zone boundary, eight of nine representatives answered "oppose," half of which were "strongly oppose" (the other respondent answered "didn't know"). The most frequent reason for opposition was that it would be disruptive to existing socioeconomic relationships with towns in Minnesota like Moorhead. Three representatives stated that the whole state should be in one time zone rather than two.

Current socioeconomic patterns in South Dakota. The cities of Pierre, in Hughes County, and Aberdeen, in Brown County, appear to have the strongest socioeconomic connections to the South Dakota counties polled (Fig. 7). In each case, respondents indicated that residents two to three counties away had connections to each town. Moving the MST-CST zone boundary farther east than its current location would likely be problematic to residents in several counties where representatives responded—Campbell, Walworth, Potter, Hand, and Brule. Moving it beyond the twenty-inch isohyet, based upon the reach of Aberdeen and Sioux Falls, will also likely disrupt social and economic ties residents currently have with these and other communities.

Six of nine representatives stated that most county residents would be opposed to moving the time zone boundary farther east to more closely align with the twenty-inch isohyet, with four of these giving strongly opposed responses. The most frequently cited reason for opposition was, like in North Dakota, that the state should not be split between two time zones even though it currently is. Of the three representatives who answered "neither favor nor oppose," one said that residents are used to such a split. Other reasons for opposition were concern about the sun going down too early in the evening; farmers would not like it; television programming is adjusted to CST;

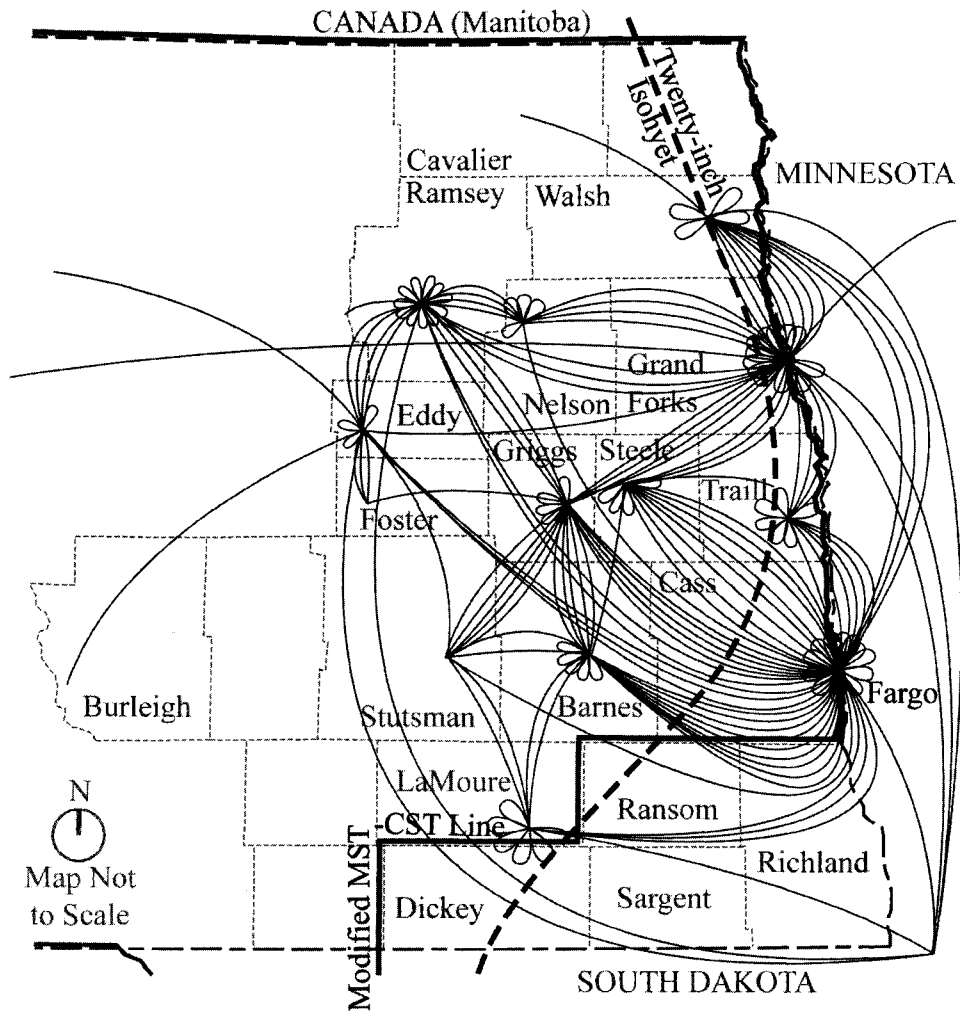


FIG. 6. Mapped responses from North Dakota county representatives showing socioeconomic relationships.

it is unwelcome; and the most exclamatory explanation from a representative in Hyde County, "Holy smacks! My kids' schedules will be crazy!"

Current socioeconomic patterns in Nebraska. Based on the data received from Nebraska county representatives, the city of North Platte, in Lincoln County, appears to have a strong connection to neighboring Nebraska counties (Fig. 8). An MST-CST zone boundary aligned with the isohyet may be too disruptive for residents in Blaine and Dawson

Counties, which currently have socioeconomic connections to North Platte, and possibly even Custer County, which did not have a representative complete a questionnaire. In addition, Red Willow and Furnas Counties have close ties. Moving the standard time zone boundary farther east than the modified MST-CST zone boundary would likely prove difficult, too, because towns and cities are more numerous and located closer to one another in the eastern part of the state.

Representatives' answers to how most residents would feel about moving the time

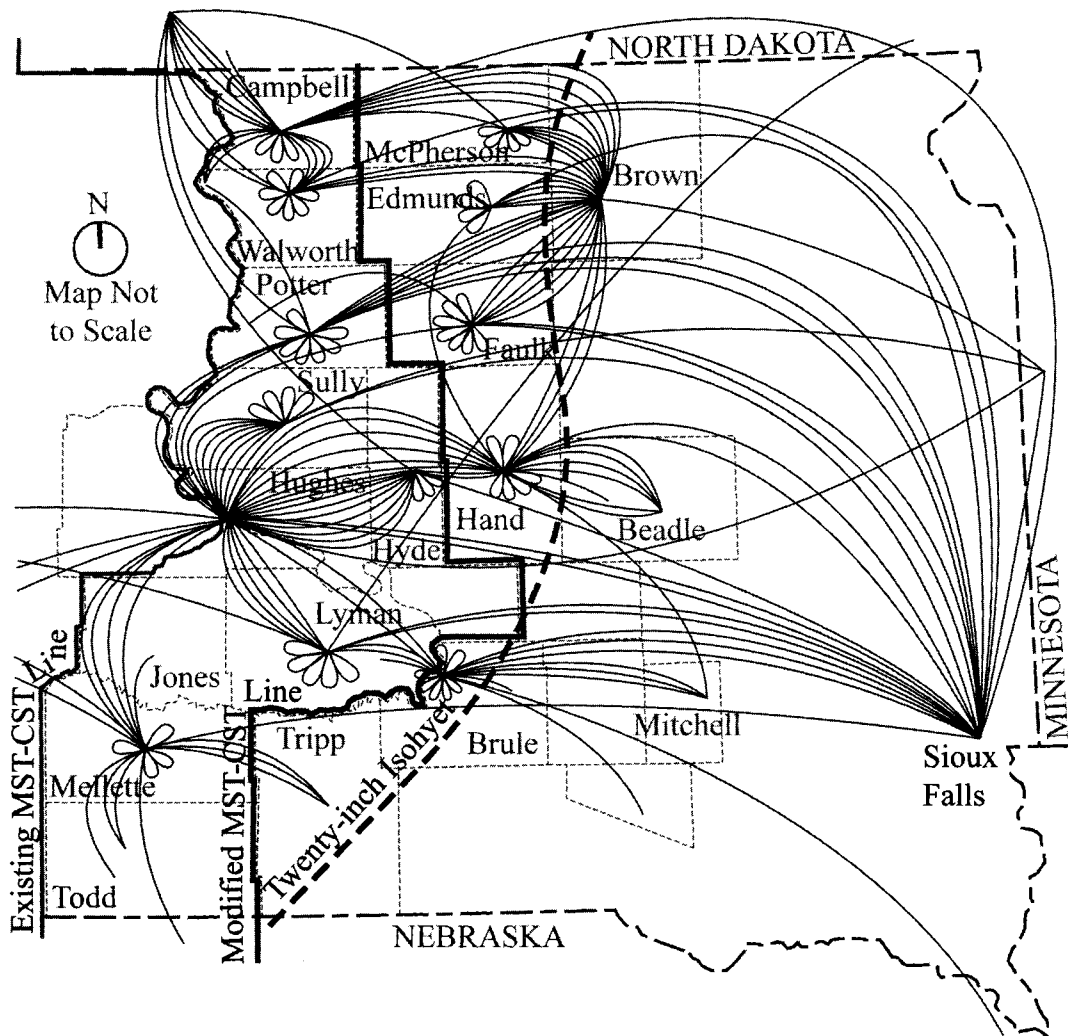


FIG. 7. Mapped responses from South Dakota county representatives showing socioeconomic relationships.

zone boundary farther east were split almost equally between “neither favor nor oppose,” “oppose,” and “strongly oppose.” One was unsure. Three of those who answered “oppose” stated they could not give a good explanation and just reacted to the question “off the cuff,” as the representative in Blaine County put it. Statements from other representatives expressing general satisfaction with observing CST may explain these responses. One representative stated that it would be easier if the whole state observed one time zone.

Current socioeconomic patterns in Kansas. Of the counties where representatives were contacted, the town of Hays, in Ellis County, appears to have the most numerous socioeconomic connections to other Kansas counties (Fig. 9). A modified MST-CST zone boundary will create tension between Ellis, Sheridan, and Gove Counties. The connections Edwards County has with Dodge City, in Ford County, will be strained as well. For comparison, moving the standard time zone boundary just west of the twenty-inch isohyet may disturb

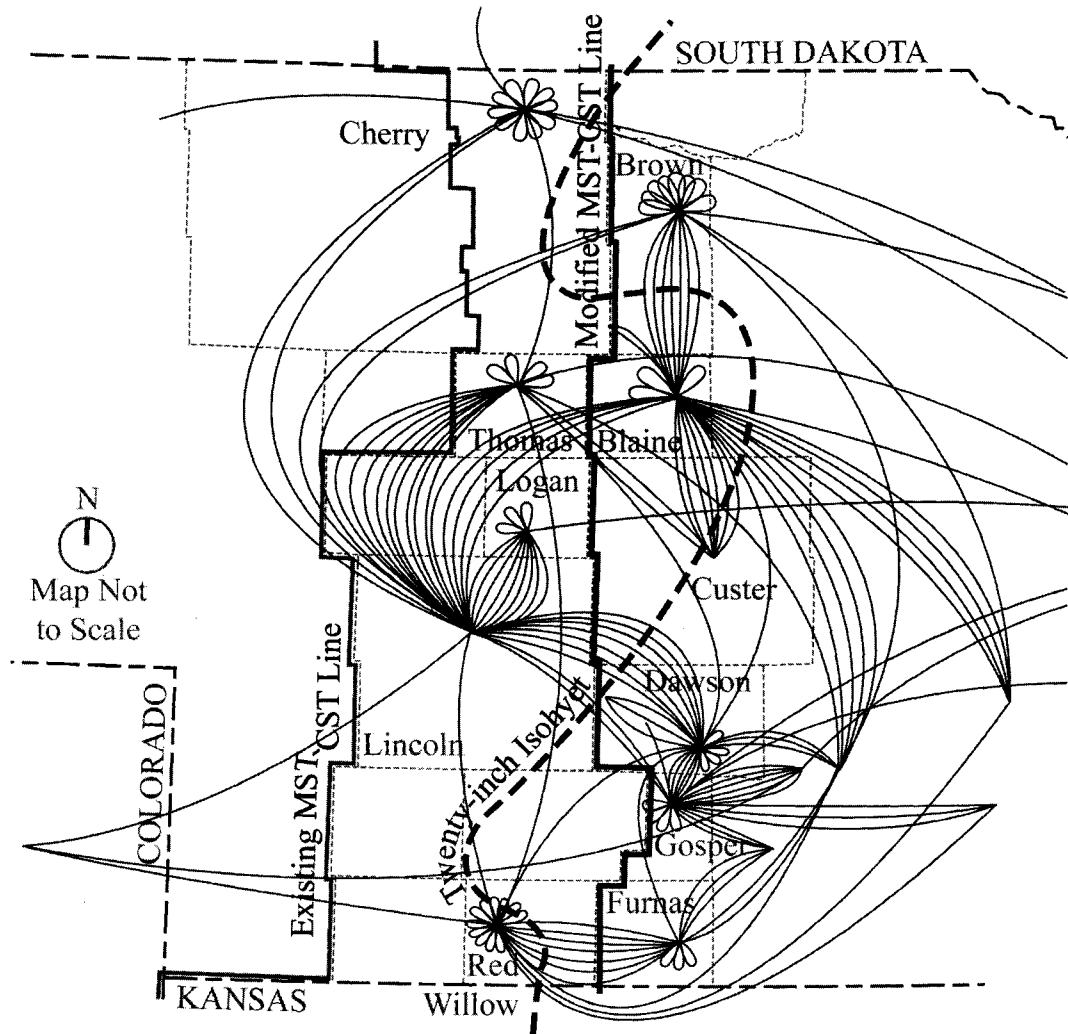


FIG. 8. Mapped responses from Nebraska county representatives showing socioeconomic relationships.

the socioeconomic connections that residents in Decatur, Sheridan, and Gove Counties currently have with Thomas County and those that Lane County have with Finney and Ford Counties.

Eight of nine representatives said that most residents in their respective counties would be opposed to moving the time zone boundary, with five of them answering "strongly oppose." Four representatives said that the confusion accompanying the coordination of appointments and activities on either side of the time

zone boundary would lead to opposition to the move. Another representative responded by saying, "Why would you do that?" with an air of disgust at being asked to consider the move. Of all representatives polled in the followup questionnaire, out of all six states, the only representative to answer favorably ("strongly favor") to moving the time zone boundary said his constituents would be "OK with it just so long as they left it alone once they moved it."²⁶ At least one representative wished that all of Kansas was within one time zone.

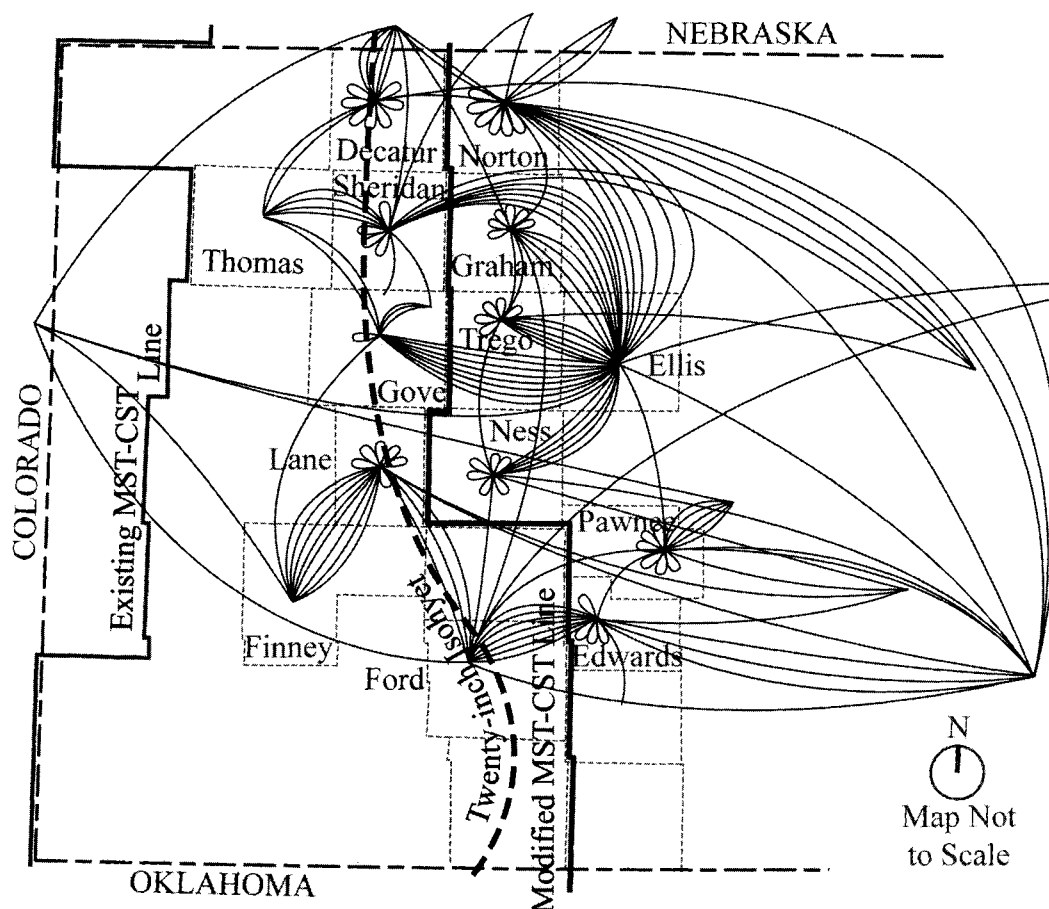


FIG. 9. Mapped responses from Kansas county representatives showing socioeconomic relationships.

Current socioeconomic patterns in Oklahoma. Of the six states examined in this study, Oklahoma may have the strongest potential for aligning the standard time zone boundary with the twenty-inch isohyet, which passes through Beaver County, in the panhandle (Fig. 10). Cimarron, Texas, and Beaver Counties each appear to have strong socioeconomic connections to Amarillo, Texas, to the south, or to locations in Kansas, to the north. Few connections exist that cross 100 degrees west longitude, which serves as the boundary between Texas on the west and Oklahoma on the east. Given the data, moving the standard time zone boundary to this location may result

in little stress to socioeconomic ties in the Oklahoma panhandle. However, separating the panhandle from the rest of Oklahoma, which has been legally forbidden in some cases due to historical precedents, may prevent this change from occurring.²⁷

Temporally severing the state was the most frequent reason representatives gave for their opinion that most residents in their respective counties would oppose moving the time zone boundary. All six were opposed, with four strongly opposed. Residents in the panhandle are especially sensitive about being forgotten by the rest of Oklahoma residents. The representative in Beaver County said that she

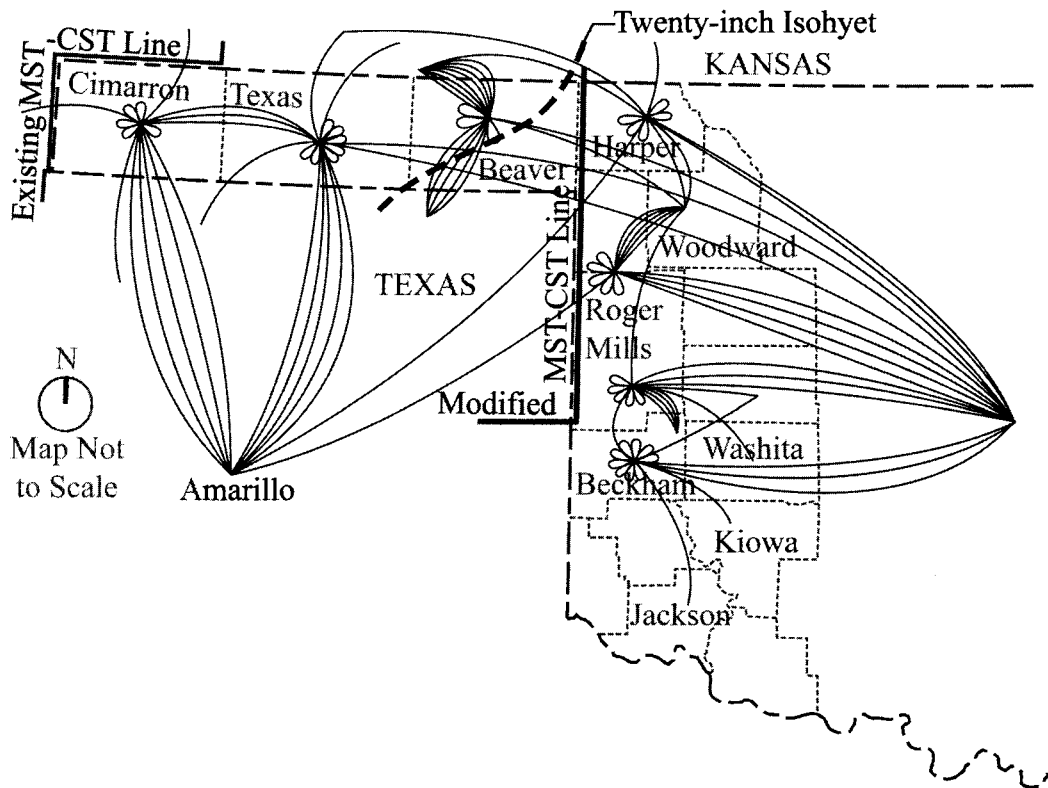


FIG. 10. Mapped responses from Oklahoma county representatives showing socioeconomic relationships.

avoided watching a television station based in Oklahoma City because the weatherman always stands in front of the panhandle when giving the forecast. Farther west, in Cimarron County, the representative stated that most residents want to be on the same time as Amarillo, Texas, and Oklahoma City, the nearest metropolitan areas.

Current socioeconomic patterns in Texas. The data received shows that the cities of Amarillo, Lubbock, San Angelo, and San Antonio in the counties of Potter, Lubbock, Tom Green, and Bexar, respectively, have the most numerous socioeconomic connections to other counties in the portion of Texas near the isohyet (Fig. 11). The twenty-inch isohyet passes to the east of Amarillo and Lubbock, to the west of San Angelo, and to the southwest of San Antonio.

A modified MST-CST zone boundary aligned with the isohyet could possibly strain numerous socioeconomic relationships between these and surrounding counties. Moving the standard time zone boundary out of range of counties that are connected socioeconomically would, in the north, result in the current MST-CST zone boundary location, and, in the south, be so far away from the twenty-inch isohyet as to no longer relate to it.

Some of the most colorful and emphatic opposition against moving the time zone boundary came from county representatives in Texas. Representatives were so moved by the question that some initially answered in their own way. "No. No. No!," said the representative in Hall County. The representative in Wheeler County was unsure and held the phone to ask two local gentlemen visiting her office who

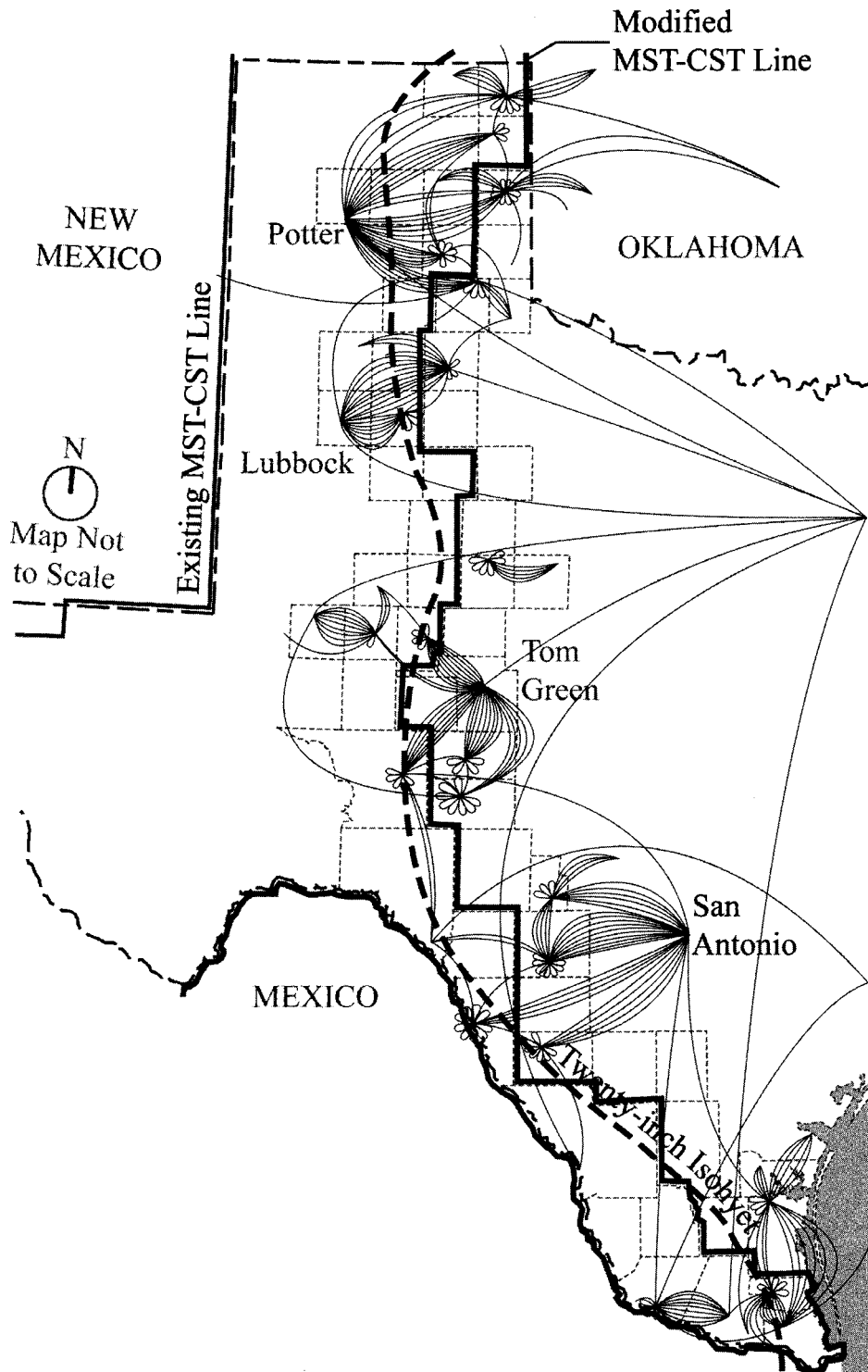


FIG. 11. Mapped responses from Texas county representatives showing socioeconomic relationships.

could be heard to say, "Hell no." The Likert-type scale appeared ineffective in communicating the strength of opposition for others, like the representative in Uvalde County who tried every way to express his opposition: "There's no waiver on that. It's almost unanimous. It would make a lot of people uncomfortable. No!" Overall, fifteen of seventeen said that most residents in their respective counties would oppose moving the time zone boundary, with eleven of these answering "strongly oppose." The remaining two representatives answered "neither favor nor oppose." Those answering "oppose" mostly cited the socio-temporal disruption and confusion that would result from frequent business and travel between nearby towns. As the representative in Kenedy County put it, "Those are [our] neighbors. Can you imagine being in a different time zone than the county beside yours?" Although one representative stated that "everybody considers El Paso part of New Mexico" (El Paso, Hudspeth, and extreme northwestern Culberson Counties in West Texas observe MST), four representatives would like the entire state to observe one time zone.

Other responses. Responses regarding when representatives wake and retire during the day and when residents work and shop appear to be unaffected by the latitudinal differences in the amount of daylight that exists; responses regarding the elimination of daylight saving time do appear to be affected. Overall, representatives appear to slightly favor doing away with DST. Twenty-five representatives answered "favor" or "strongly favor" and eighteen answered "oppose" or "strongly oppose" (fifteen answered "oppose"). Representatives in North and South Dakota, where the amount of daylight fluctuates most between the winter and summer solstices in comparison to the other states, gave more opposed answers than favorable. Having more daylight in the evening hours was indeed the most frequent reason behind these answers in both states, especially for residents who work "9 to 5." Generally, this explanation was given with "oppose" answers

no matter the location. Favoring the removal of daylight saving time was usually accompanied by a comment expressing the inconvenience or "hassle" of changing time twice a year. Twelve representatives gave "neither" answers followed by explaining that "some [residents] are for, some are against." Also of interest was the way in which representatives answered the followup questions. When asked about doing away with daylight saving time, laughs or long pauses preceded answers suggesting that the issue is unclear, even humorous. The question about moving the time zone boundary was answered, in most cases, curtly, with an occasional skeptical or defensive inquiry preceding an answer. With the exception of Texas, most respondents identified the region they lived in as "Midwest" or "Central"; most in Texas said they lived in the "Southwest." Overall, only five respondents (7.2 percent) said they lived in the Plains; two stated both the Midwest and the Plains in their responses.

Time and again, representatives noted that clocks have little effect on county economies based in extractive industries: farmers, ranchers, and oilmen and women work from sunup to sundown. Moving south, the number of major elements comprising the local economy increased: farming was viewed as a major element in the Northern Plains; ranching and farming were important in the Central Plains; oil and gas exploration and production along with farming and ranching are important in the Southern Plains. Just under half the respondents ($n = 33$) said that the local county economy was holding steady. Almost equal numbers said that it was declining or growing ($n = 15$ and 13 , respectively). Many representatives noted that economic development was actively occurring. The development of wind energy was a recurring response in South Dakota, Oklahoma, and Texas.

The effects on railroads. According to an Amtrak operations representative, Amtrak would be minimally affected by changing the location of the standard time zone boundary in the Great Plains. The California Zephyr,

Empire Builder, and Southwest Chief lines each have two trains that cross the MST-CST zone boundary daily. The Texas Eagle crosses it three days a week in each direction.²⁸ In each case, the timetables available to passengers and crew base locations follow local standard time, including variations and exceptions like a state not observing daylight saving time. If time observance were to change, the representative wrote, the timetables and observance of time at crew bases would change as well. However, operations at Amtrak, which shares rail lines with freight railroad companies like CSX or Union Pacific, may be forced to follow the "company standard" times and varied time zone boundaries observed by the freight railroads.

Currently, Union Pacific, which has hundreds of trains crossing the MST-CST zone boundary daily, observes a slightly different time zone boundary than the rest of Lincoln County, Nebraska. East of North Platte, home to the largest freight classification yard in the world, the Bailey Rail Yard, Union Pacific observes CST; west of North Platte it observes MST. According to Steve Barkley, vice president of the Harriman Dispatching Center and Network Operations at Union Pacific, moving the time zone boundary would not coincide with the location of crew changes and cause confusion regarding the federal hours of service law, which limits the number of hours a crew member may work in a single period to twelve. Should a time zone boundary change occur, software programs including the computer-aided dispatching system would need changes, which would require substantial investment. If it changes in Nebraska, or in Kansas and Texas where other crew bases also exist, Barkley said, Union Pacific probably would not change their definitions of time observance.

International effects. Modifying the MST-CST zone boundary would likely cause interference with international socioeconomic relationships. In the north, along the Saskatchewan–Manitoba–North Dakota border, the degree of interference depends upon the selected time

zone boundary alignment and whether daylight-saving time will continue being observed. Currently, the northern portion of North Dakota shares time with both Canadian provinces during standard time, but only Manitoba during daylight saving time (Saskatchewan does not observe DST). If the time zone boundary were to be aligned with the isohyet and DST continued, most of North Dakota would only share time with Saskatchewan during standard time (Figs. 2 and 3). If the time zone boundary were to be aligned with the western state boundary and DST eliminated, North Dakota would share time with both Saskatchewan and Manitoba during standard time and only Saskatchewan during the summer months when other states and provinces are observing DST (Figs. 4 and 5). Although existing socioeconomic relationships between Manitoba and North Dakota may be strained in either scenario, when compared to how time is currently observed, the latter is least disruptive.

Major cities in the Mexican states of Coahuila, Nuevo Leon, and Tamaulipas share boundaries with Texan counties that would lose an hour if the MST-CST zone boundary were aligned with the twenty-inch isohyet, thus making it likely that socioeconomic disruption would occur. In southern Texas, a temporal peninsula would be created, isolating residents from other Texan and Mexican communities (Figs. 2 and 3). Moving the time zone boundary to the western boundary of Texas and eliminating DST would synchronize many Texan and Mexican communities during standard time while separating them during the summer months (Figs. 4 and 5). To minimize the disruption of socioeconomic activities in the latter scenario, relocating the time zone boundary in Mexico would have to occur in remote areas within the states and DST would have to be eliminated.

In sum, existing international socioeconomic relationships between the United States, Mexico, and Canada would be strained by modifying the MST-CST zone boundary in the United States. However, both Mexico

and Canada have mirrored DST observance changes in the United States before. In 2007, legislation was introduced in Manitoba that extended DST to match that of the United States; in March 2010, Mexico's House of Representatives passed a similar law that allowed cities along the Texas-Mexico border to begin DST when Texas communities did.²⁹ A domino effect of time observance debates and changes may nevertheless occur in Mexico and Canada as a result of any time change in the United States.

CONCLUSION

Of the two possible alternative locations for the MST-CST zone boundary examined in this study, aligning it with existing state boundaries seems most feasible but still problematic. Responses from county representatives in North Dakota, South Dakota, Nebraska, Kansas, and Texas showed that moving the MST-CST zone boundary to coincide with the twenty-inch isohyet would disrupt existing socioeconomic relationships. Socioeconomic patterns in Oklahoma appear to be mostly immune to a move that would temporally separate the panhandle from the rest of the state, but such a separation is highly unlikely due to past and present instances that occurred for other reasons and were unwelcome by residents. On the other hand, county representatives in each of the other states currently bisected by the MST-CST zone boundary offered support for synchronizing time within the state, even though they said that moving the time zone boundary to align with the isohyet would likely meet strong opposition from residents.

If the move were to occur, two positive and related outcomes follow: first, individual states could realistically opt out of observing DST and share time with at least one neighboring state throughout the year. As was recently expressed by Senator Shilz and residents in Nebraska, eliminating DST could eliminate health, social, and business problems that stem from changing time twice a year. On the whole, county representatives in this study slightly

avored doing away with DST, with the greatest opposition in North and South Dakota where the extra daylight in the evenings is desired. Second, an alignment with state boundaries could encompass and reflect the ambiguous nature of the eastern boundary of the Great Plains. County representatives straddling the twenty-inch isohyet generally viewed the region in which they live as the central United States and the Midwest, not the Great Plains. Annual rainfall totals that fluctuate over time and space may contribute to this perception as may practicing water-intensive agriculture, made possible by the Ogallala aquifer. General circulation models show that changes in precipitation, evapotranspiration, crop and water yields and variability, and time needed to grow swine and beef cattle due to increasing greenhouse gases appear to occur near the location of the twenty-inch isohyet. Observing Central Standard Time year-round within North and South Dakota, Nebraska, Kansas, Oklahoma, and Texas acknowledges these historical and potential future relationships to the eastern and western United States.

Nevertheless, a number of obstacles must be addressed. As one county representative in North Dakota noted, existing interstate socioeconomic relationships that are currently unaffected by a time change may become strained by aligning the MST-CST zone and state boundaries and eliminating DST. Counties in North and South Dakota, Kansas, and Texas that would have to switch from observing MST to CST have resisted or reversed similar changes in the past.³⁰ Union Pacific Railroad would probably not support moving the MST-CST zone boundary, no matter the location; Amtrak may defer to the opinions and actions of Union Pacific and other freight railroads with which they share tracks. International socioeconomic connections between North Dakota and Saskatchewan would be out of sync during the summer months, as would connections between Texan counties and Mexican states. In each case, changing the MST-CST zone boundary could adversely affect socioeconomic

activities on scales ranging from local to international.

Within the Plains, the majority of responses stating that county economies are holding steady imply that existing socioeconomic relationships will remain in place. Projections of the Great Plains population and economy could additionally prevent changing the location of the MST-CST zone boundary in the foreseeable future. A continual depopulation, reliance on diminishing groundwater supplies and intensive agriculture, and the more dire effects of global climatic change may create social and economic connections that are more easily disrupted than those that exist today, particularly in small towns and villages. Goods, services, and sources of information may become more concentrated in fewer towns having the largest populations and capital to support them. Consequently, the number and distance of socioeconomic connections to these towns could increase.

Future research should begin by surveying representatives in counties that straddle the western and eastern state boundaries of North and South Dakota, Nebraska, Kansas, Oklahoma, and Texas to further test possible alignments of the standard time zone boundary. Beyond understanding the current and projected socioeconomic connections communities have, and their preferences for time observance, the investigation should include questions about attitudes, opinions, perceptions, and behaviors of regional environmental characteristics. "Mountain" standard time is appropriate given the general geographic vocabulary used for the other time zones—Eastern, Central, and Pacific. However, Webb suggested that aridity defines much of the western United States, not mountains.³¹ Residents' knowledge and perceptions may differ and should be compared to natural and social characteristics including population density and change, land use, ownership, and sizes of landholding to reveal existing overlaps that could help define regional boundaries, conservation policies, and the nomenclature used to communicate each.

Generally, future research seeking to define the eastern boundary of the Great Plains should begin by considering how social and natural boundaries relate to one another spatially and functionally. The natural availability of water will certainly play a role, as will political boundaries, which define the bodies that enforce policies. Ultimately, defining the Great Plains on maps, in the landscape, in our minds, and among communities affects the present treatment and future well-being of the land.

NOTES

1. John Opie, *Ogallala: Water for a Dry Land* (Lincoln: University of Nebraska Press, 1993), 22; Richard K. Sutton, "Circles on the Plains: Center Pivot Irrigation," *Landscape* 22, no. 1 (1977): 3–10.

2. Nebraska Legislature, 102nd Legislature, 1st sess., Day 11, 2011, Government, Military, and Veterans Affairs Committee. LB101—Eliminate daylight savings time. http://www.nebraskalegislature.gov/bills/view_bill.php?DocumentID=12332 (accessed March 17, 2011).

3. Studies conducted after the 2005 amendment to the Uniform Time Act that extended DST observance by three weeks in the United States have questioned the energy savings that have historically been used to justify observing DST and have examined other effects of DST. *Uniform Time Act*, Public Law 109-58, 119 Stat. 615, Section 110 (August 8, 2005); Thomas Kantermann, Myriam Juda, Martha Merrow, and Till Roenneberg, "The Human Circadian Clock's Seasonal Adjustment Is Disrupted by Daylight Saving Time," *Current Biology* 17, no. 22 (November 2007): 1996–2000; Myriam B. C. Aries and Guy R. Newsham, "Effect of Daylight Saving Time On Lighting Energy Use: A Literature Review," *Energy Policy* 36 (March 2008): 1858–66.

4. The Canadian Province of Saskatchewan also does not observe DST. During the winter residents share CST with Manitoba to the east; in spring and summer, residents share Mountain Daylight Time (MDT) with Alberta to the west. Government of Saskatchewan, "Saskatchewan Time: A Scientific and Historical Background," <http://www.municipal.gov.sk.ca/Administration/Guides/SaskTime> (accessed April 7, 2011).

5. North and South Dakota, Nebraska, Kansas, Oklahoma, and Texas all adopted the Western Doctrine of Riparian Rights, or the California doctrine, to allow landowners to use water in non-navigable waterways for irrigation. Each has since also converted these riparian rights into appropriate

rights whereby individuals who divert and put water to "beneficial" uses like mining and agriculture are given priority rights to water. See Walter Prescott Webb, *The Great Plains* (Boston: Houghton Mifflin, 1931), 436; and Bureau of Land Management, "Water Appropriation Systems," <http://www.blm.gov/nstc/WaterLaws/appsystems.html> (accessed April 7, 2011).

6. Opie, *Ogallala*, 324.

7. Gail P. Thelin and Frederick J. Heimes, "Figure 4, Regional Aquifer-System Analysis," in *Mapping Irrigated Cropland from Landsat Data for Determination of Water Use from the High Plains Aquifer in Parts of Colorado, Kansas, Nebraska, New Mexico, Oklahoma, South Dakota, Texas, and Wyoming* (U.S. Geological Survey Professional Paper 1400-C, 1987).

8. V. L. McGuire, "Figure 11: Water-Level Changes in the High Plains Aquifer, Predevelopment to 2007," in *Water-Level Changes in the High Plains Aquifer, Predevelopment to 2007, 2005–06, and 2006–07* (U.S. Geological Survey Scientific Investigations Report 2009–5019), <http://pubs.usgs.gov/sir/2009/5019/> (accessed March 31, 2011).

9. Norman J. Rosenberg, Daniel J. Epstein, David Wang, Lance Vail, Raghavan Srinivasan, and Jeffrey G. Arnold, "Possible Impacts of Global Warming on the Hydrology of the Ogallala Aquifer Region," *Climatic Change* 42, no. 4 (1999): 677–92; Steven J. Smith, Allison M. Thomson, Norman J. Rosenberg, R. Cesar Izaurralde, Robert A. Brown, and Tom M. L. Wigley, "Climate Change Impacts for the Coterminous USA: An Integrated Assessment, Part 1. Scenarios and Context," *Climatic Change* 69 (2005): 7–25.

10. Allison M. Thomson, Robert A. Brown, Norman J. Rosenberg, and Verel Benson, "Climate Change Impacts for the Coterminous USA: An Integrated Assessment, Part 3. Dryland Production of Grain and Forage Crops," *Climatic Change* 69 (2005): 49–65.

11. Allison M. Thomson, Robert A. Brown, Norman J. Rosenberg, Raghavan Srinivasan, and R. Cesar Izaurralde, "Climate Change Impacts for the Coterminous USA: An Integrated Assessment, Part 4. Water Resources," *Climatic Change* 69 (2005): 67–88.

12. Allison M. Thomson, Norman J. Rosenberg, R. Cesar Izaurralde, and Robert A. Brown, "Climate Change Impacts for the Coterminous USA: An Integrated Assessment, Part 5. Irrigated Agriculture and National Grain Crop Production," *Climatic Change* 69 (2005): 89–105; Rosenberg et al., "Possible Impacts of Global Warming."

13. Terry L. Mader, Katrina L. Frank, John A. Herrington Jr., G. Leroy Hahn, and John A. Nienaber, "Potential Climate Change Effects on Warm-Season Livestock Production in the Great Plains," *Climatic Change* 97 (2009): 529–41.

14. W. K. Lauenroth, I. C. Burke, and M. P. Gutmann, "The Structure and Function of Ecosystems in the Central North American Grassland Region," *Great Plains Research* 9, no. 2 (1999): 223–59; A. Townsend Peterson, "Projected Climate Change Effects on Rocky Mountain and Great Plains Birds: Generalities of Biodiversity Consequences," *Global Change Biology* 9 (2003): 647–55.

15. Ronald D. Sands and James A. Edmonds, "Climate Change Impacts for the Coterminous USA: An Integrated Assessment, Part 7. Economic Analysis of Field Crops and Land Use with Climate Change," *Climatic Change* 69 (2005): 127–50.

16. J. B. Jackson, "A Pair of Ideal Landscapes," in *Discovering the Vernacular Landscape* (New Haven, CT: Yale University Press, 1984), 13–16, 32–35. Jackson wrote that those who make boundaries try to accurately delineate them according to the internal use of space and natural or social content.

17. Yi-Fu Tuan, *Space and Place: The Perspective of Experience* (Minneapolis: University of Minnesota Press, 1977), 125.

18. J. B. Jackson, "A Sense of Place, a Sense of Time," *Design Quarterly* 164 (Spring 1995): 24–27.

19. Ian R. Bartky, *One Time Fits All* (Stanford, CA: Stanford University Press, 2007), 192.

20. This is based upon a review of the *Federal Register Reports* for the Great Plains states noted in United States Department of Transportation, *Standard Time in the United States* (Washington, DC: U.S. Government Printing Office, 1970), appendix 1. For notes on the preference for more daylight in the evening, see Bartky, *One Time Fits All*, 197, 200.

21. In 2003, residents observing MST in Jones, Mellette, and Todd Counties in South Dakota requested that each county be located entirely within CST to synchronize where people shop, live, and vote. U.S. Department of Transportation, "Standard Time Zone Boundary in the State of South Dakota: Relocation of Jones, Mellette, and Todd Counties," <http://www.epa.gov/EPA-IMPACT/2003/October/Day-28/i27056.htm> (accessed April 7, 2011).

22. Great Plains Committee, *The Future of the Great Plains. Report of the Great Plains Committee* (Washington, DC: U.S. Government Printing Office, 1936), figs. 2 and 3.

23. Frank J. Popper, "The Strange Case of the Contemporary American Frontier," *Yale Review* 76 (1986): 101–21.

24. Deborah E. Popper and Frank J. Popper, "The Onset of the Buffalo Commons," *Journal of the West* 45, no. 2 (2006): 29–34.

25. The DOT developed eight questions that are used to assist communities in determining the impact of a change in the standard

time zone boundary on the "convenience of commerce." Compound questions were broken down into individual questions in this study to isolate questionnaire responses for analysis. U.S. Federal Register, govpulse, "Standard Time Zone Boundary in the State of North Dakota: Proposed Change for Mercer County, North Dakota, From Mountain to Central Time Zone," <http://govpulse.us/entries/2010/03/03/2010-4372/standard-time-zone-boundary-in-the-state-of-north-dakota-proposed-change-for-mercercounty-north-dak> (accessed April 7, 2011).

26. The last change to the standard time zone boundary in Kansas occurred in 1969. U.S. Department of Transportation, *Standard Time*, 21.

27. Arthur H. Doerr and John W. Morris, "Oklahoma Panhandle," *Landscape* 10, no. 1 (Fall 1960): 32–35. The Oklahoma panhandle was forgotten when the New Mexico and Kansas territories were initially delineated and became a no-man's-land for outlaws. Later, to save printing costs in textbooks, early Oklahoma maps left off the panhandle. It has since become law that all of Oklahoma, including the panhandle, be shown on maps.

28. The information regarding the number of crossings per line is based on a review of current Amtrak timetables. <http://www.amtrak.com/servlet/ContentServer/Page/1237405732505/1237405732505> (accessed April 7, 2011).

29. Diario Oficial de la Federación, Secretaría de Gobernación, Estados Unidos Mexicanos, http://dof.gob.mx/nota_detalle.php?codigo

=5127480&fecha=06/01/2010 (accessed April 4, 2011); Province of Manitoba, Canada, "Province Introduces Legislation That Would Extend Daylight Saving Time in Manitoba," November 2, 2005, <http://www.gov.mb.ca/chc/press/top/2005/11/2005-11-02-06.html> (accessed April 4, 2011).

30. CST was extended to include all but the most extreme southwestern corner of North Dakota in 1929. The change was reversed in 1968 after both a petition from the governor and a time preference ballot in the September primary election that stated residents' preference for MST. In South Dakota, a 1963 petition to extend CST to include the western half of the state was denied. A governor and state legislature's petition to include the entire state of Kansas in CST received a limited number of responses that were overall in favor of remaining in MST. A proposal to include all western counties except the four currently in MST was enacted in 1969. Finally, one of the most recent alterations of the MST-CST boundary in the Great Plains, in El Paso and Hudspeth Counties in Texas, occurred in 1970, when these counties were restored to MST. U.S. Department of Transportation, *Standard Time*, appendix 1; *Federal Register* 32, no. 153 (August 9, 1967): 11479; *Federal Register* 33, no. 122 (June 22, 1968): 18062; *Federal Register* 33, no. 188 (September 26, 1968): 14470.

31. Walter Prescott Webb, "The American West, Perpetual Mirage," *Harper's Magazine* 214, no. 1284 (May 1957): 25–31.